Using a micro-UAV for ultra-high resolution multi-sensor observations of Antarctic moss beds

Arko Lucieer, Sharon Robinson (UoW), Darren Turner & Steve Harwin

School of Geography & Environmental Studies

University of Tasmania

The 12th International Circumpolar Remote Sensing Symposium

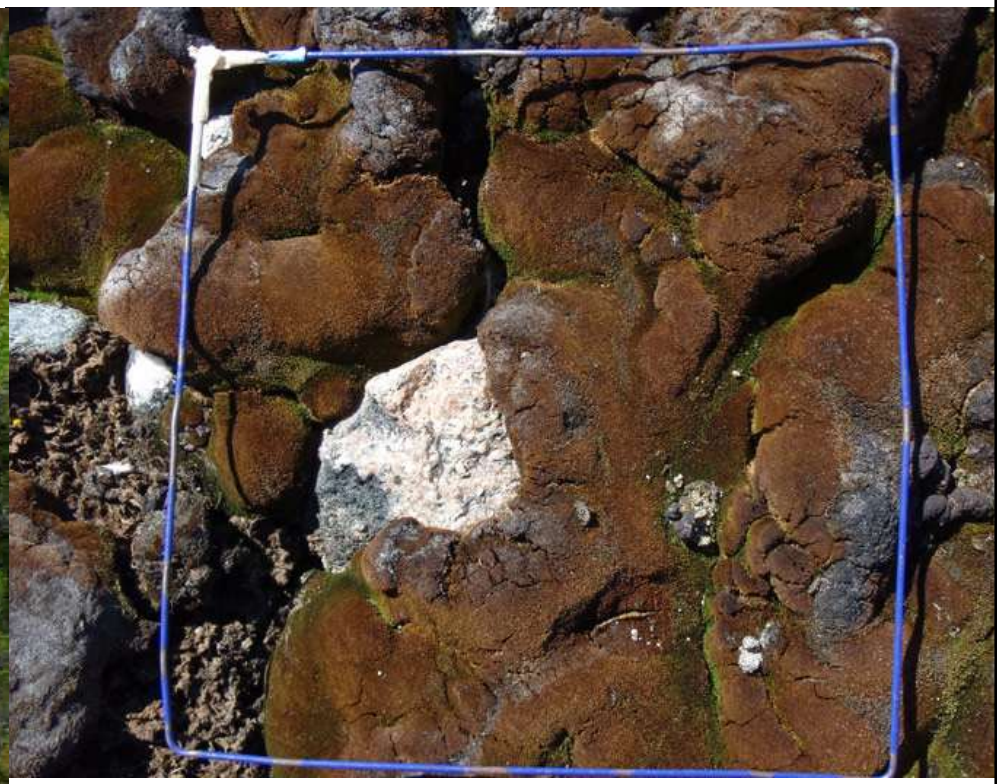
Levi, Finland, 14 – 18 May 2012

UTAS


1957
1961
1974
1982
1994
1999
10 mm

Life is getting tougher

2003



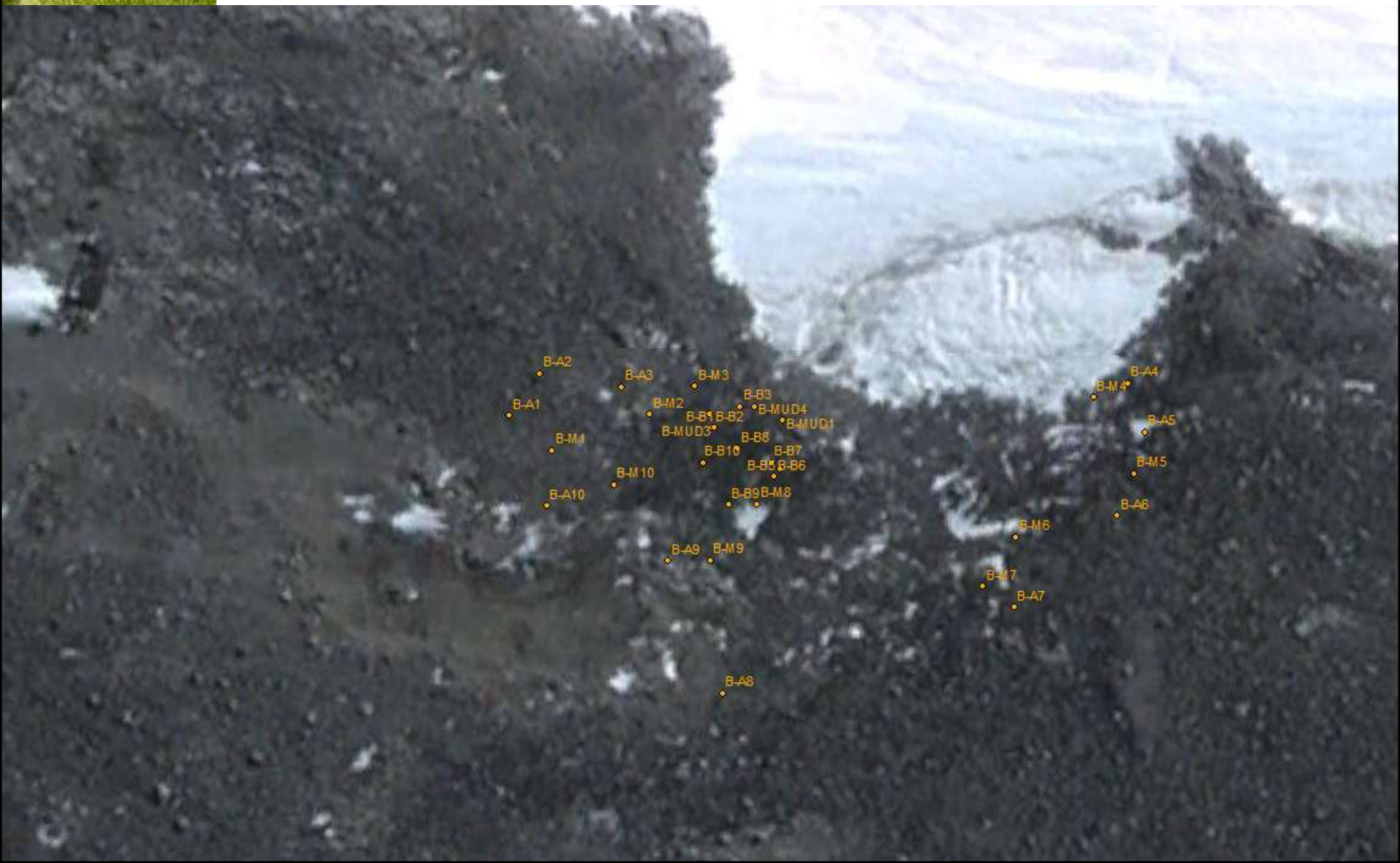
2008

Source: Prof. Sharon Robinson

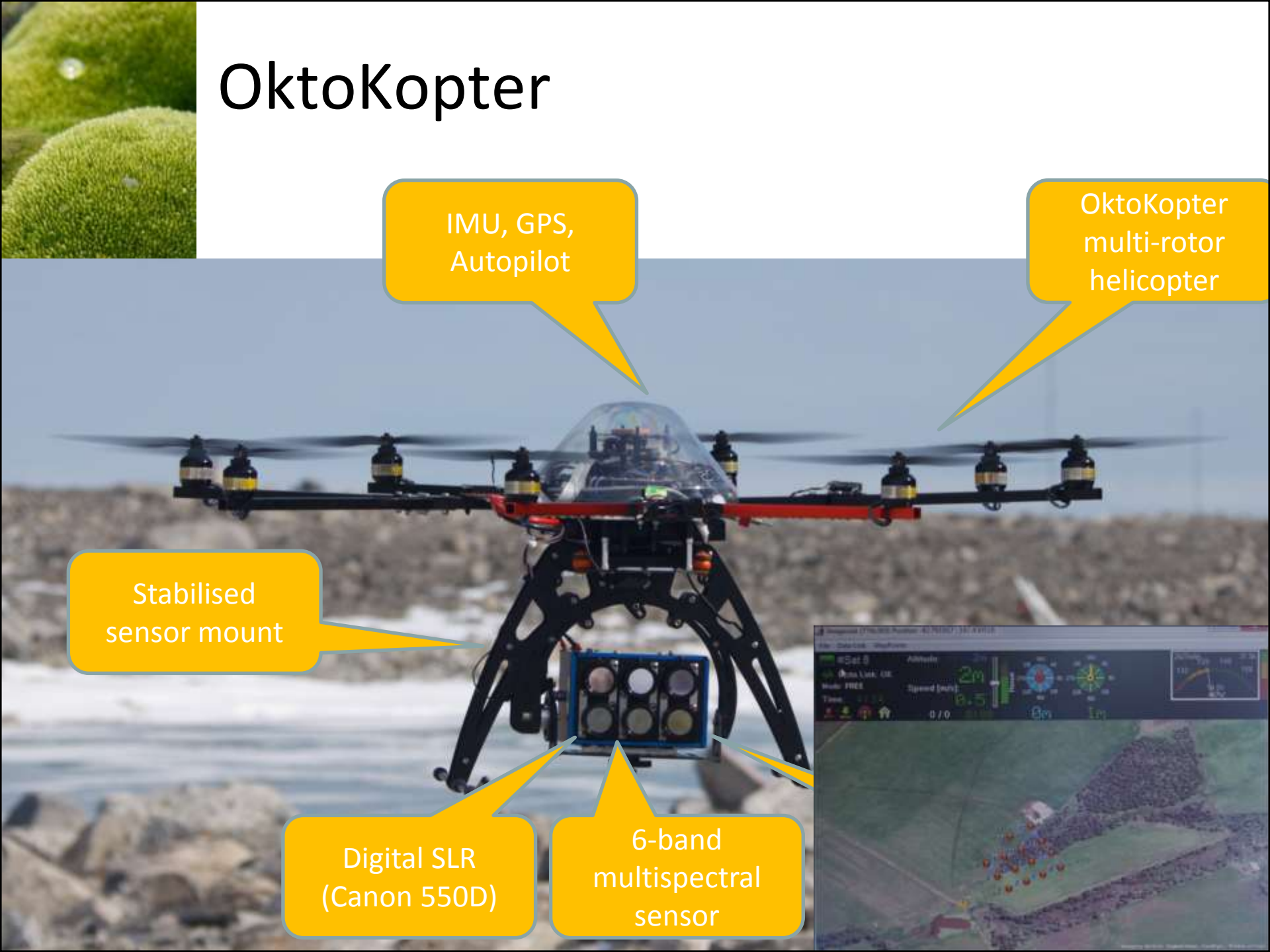
UTAS

QuickBird 2006

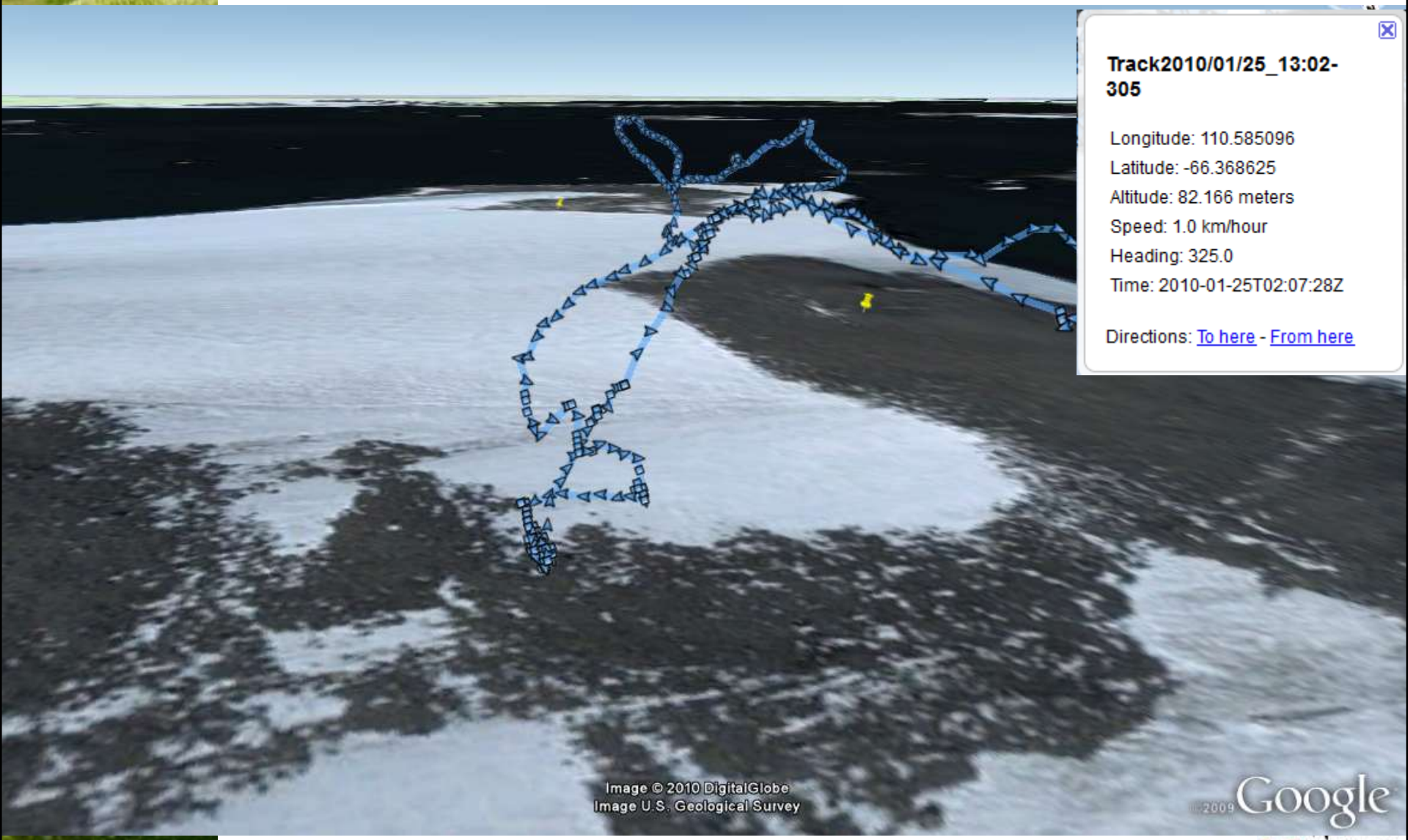
Antarctic Special Protected Area 135



OktoKopter

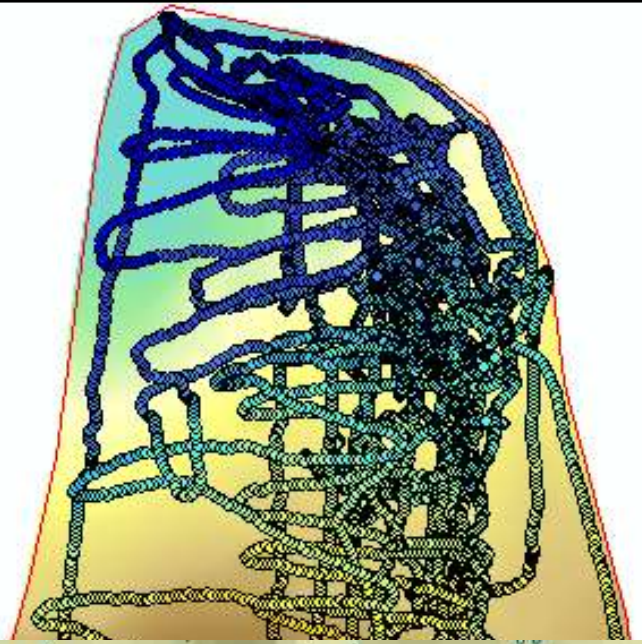

IMU, GPS, Autopilot
OktoKopter multi-rotor helicopter
Stabilised sensor mount
Digital SLR (Canon 550D)
6-band multispectral sensor

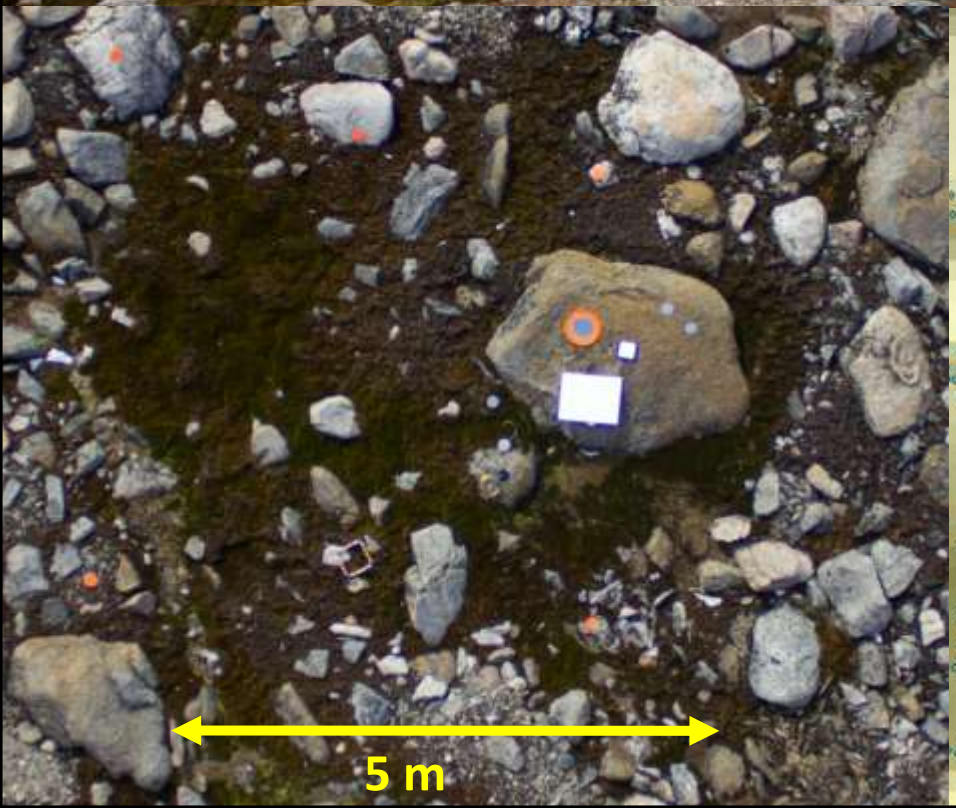
Flight path in Google Earth



Objectives

- To map the spatial extent and health of Antarctic moss beds from UAV photography, multispectral, and thermal imagery
- To capture micro-topography of the moss bed environment based on Structure from Motion (SfM) point clouds




5 m

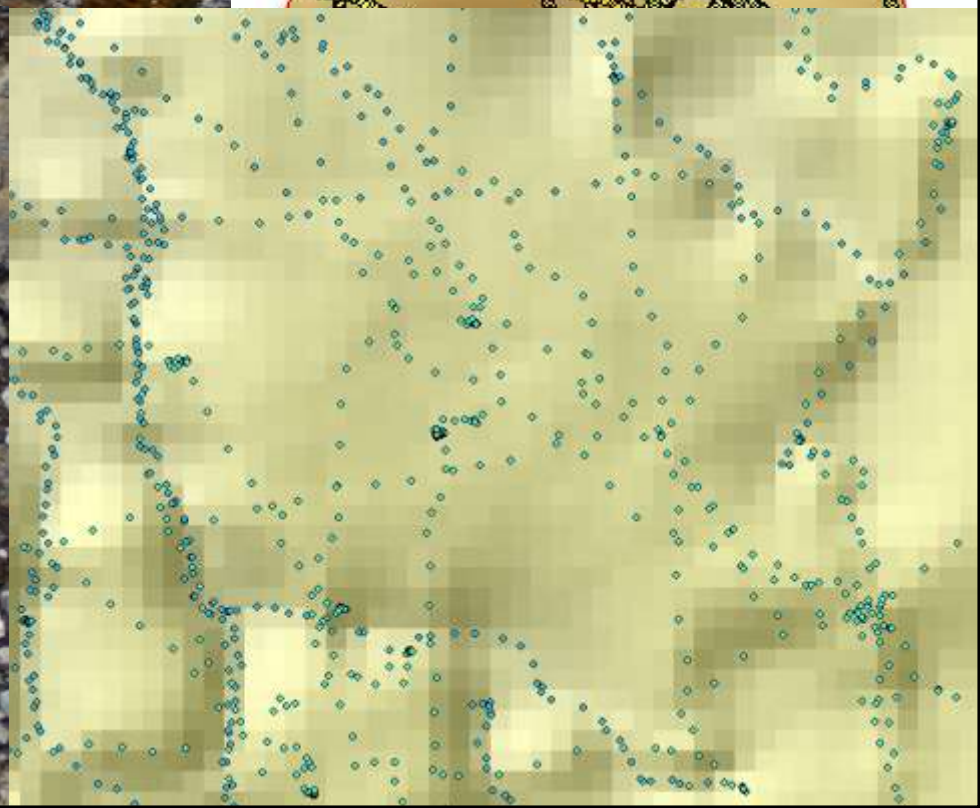


Photo Tourism - Bundler

- Technique: Structure from Motion (SfM)
- Determines location, orientation, and radial distortion of cameras and sparse 3D geometry

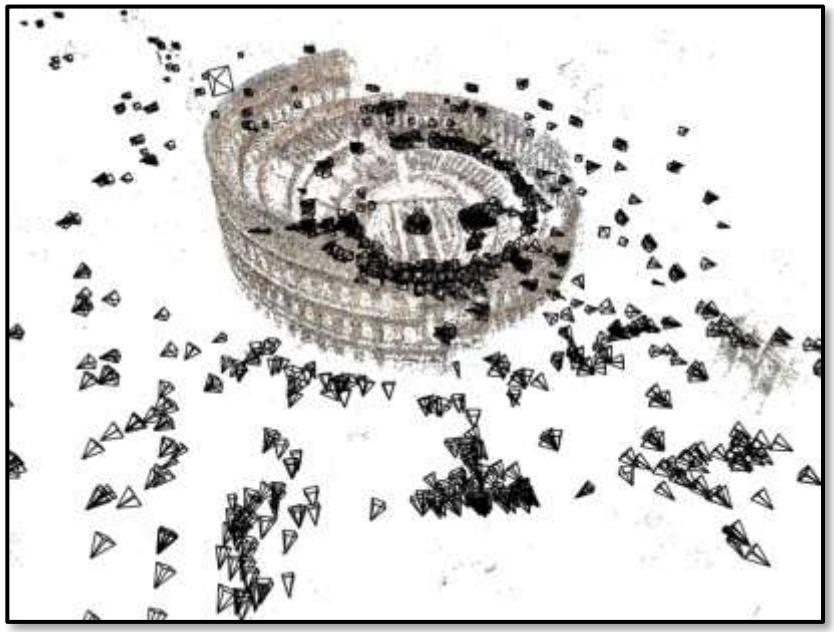
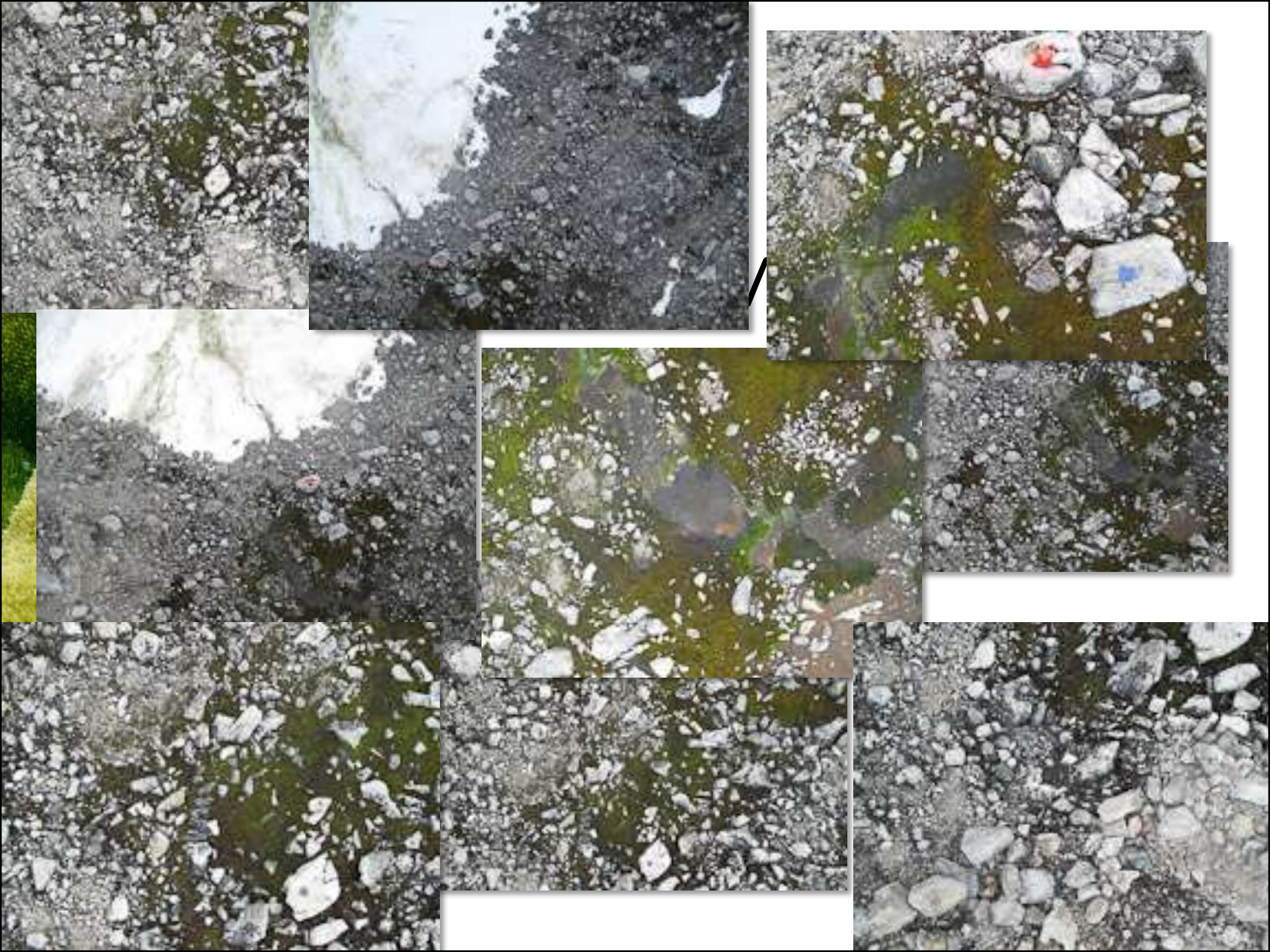


Photo Tourism: Exploring image collections in 3D
Noah Snavely, Steven M. Seitz, Richard Szeliski
Proceedings of SIGGRAPH 2006

UTAS

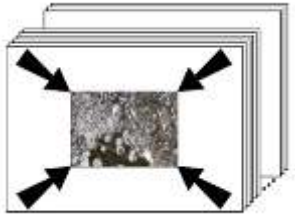


PMVS2

- Patch-based Multi-View Stereo
- Furukawa, Y., & Ponce, J. (2009). Accurate , Dense , and Robust Multi-View Stereopsis. *IEEE Transactions on Pattern Analysis and Machine Intelligence*.
- Multi-view stereopsis for dense point reconstruction
- Match, expand, filter procedure
- Start with camera positions and sparse point cloud and expand patches
- Filter out false matches

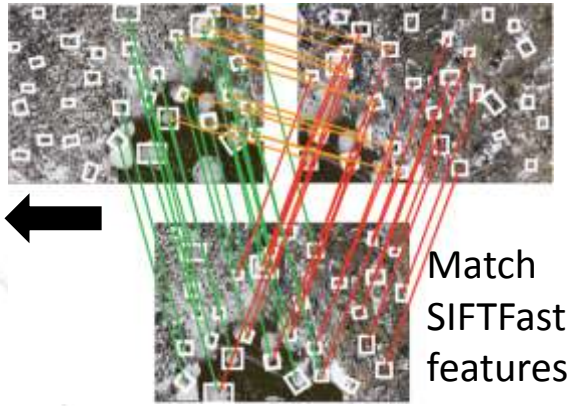
UAV-MVS Point Cloud Generation

Full size image stack

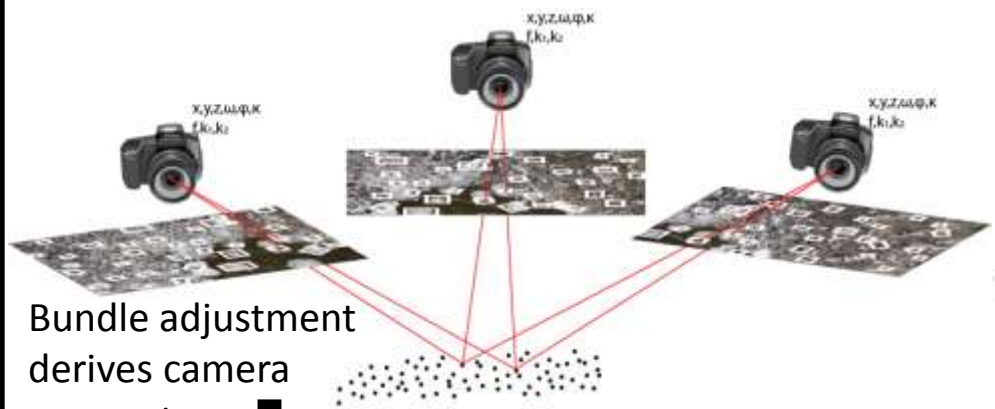


Resized image stack

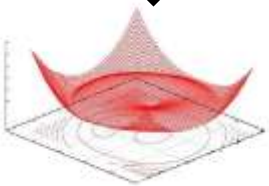
Extract SIFTFast features



Match SIFTFast features

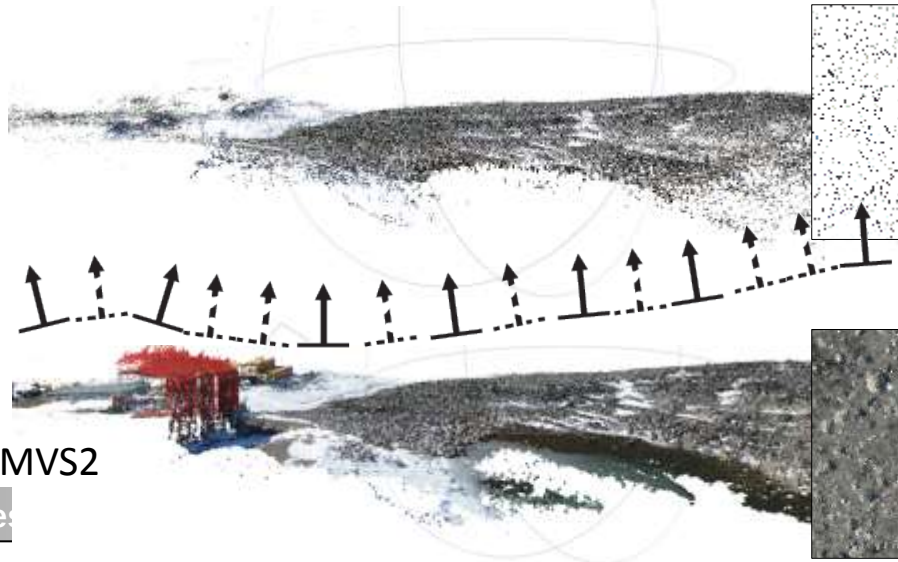


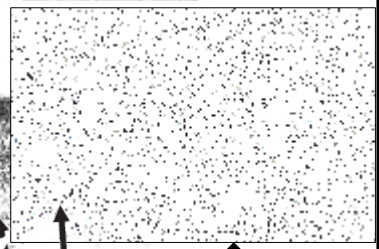
Bundle adjustment derives camera parameters



Remove radial distortion from full size images

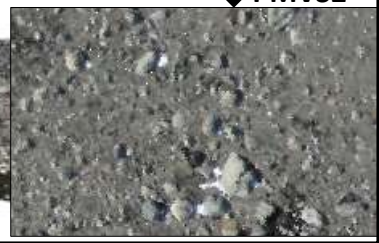
Densify point cloud via PMVS2





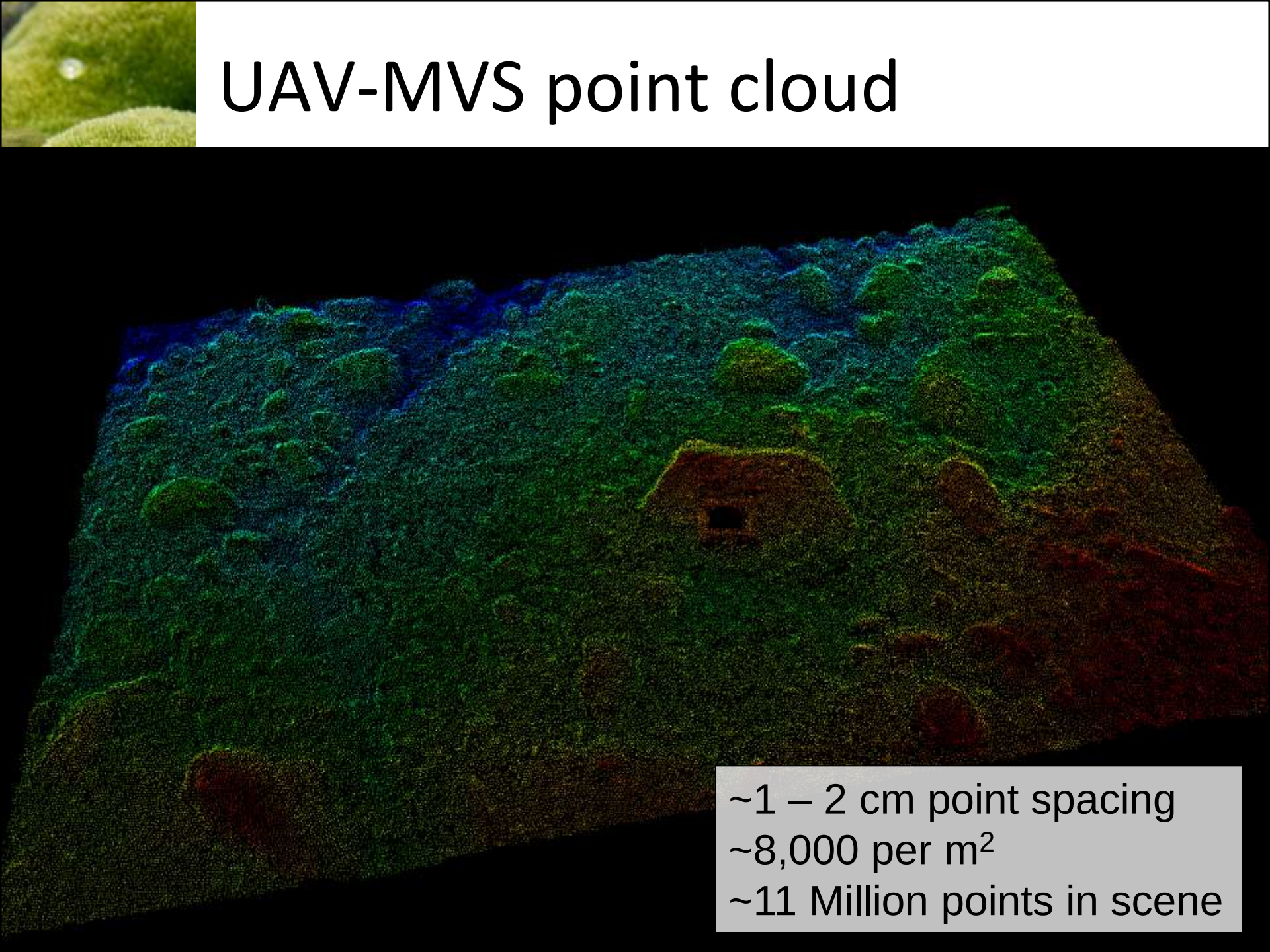
Bundler

PMVS2

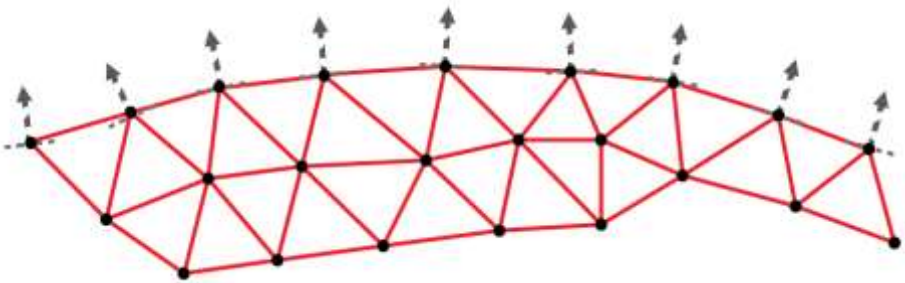


UAV-MVS point cloud

UAV-MVS point cloud

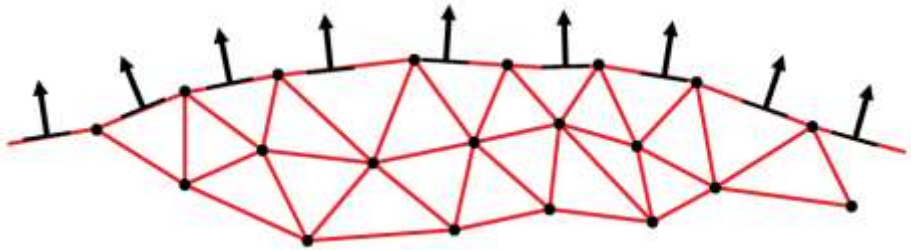


Terrain surface interpolation

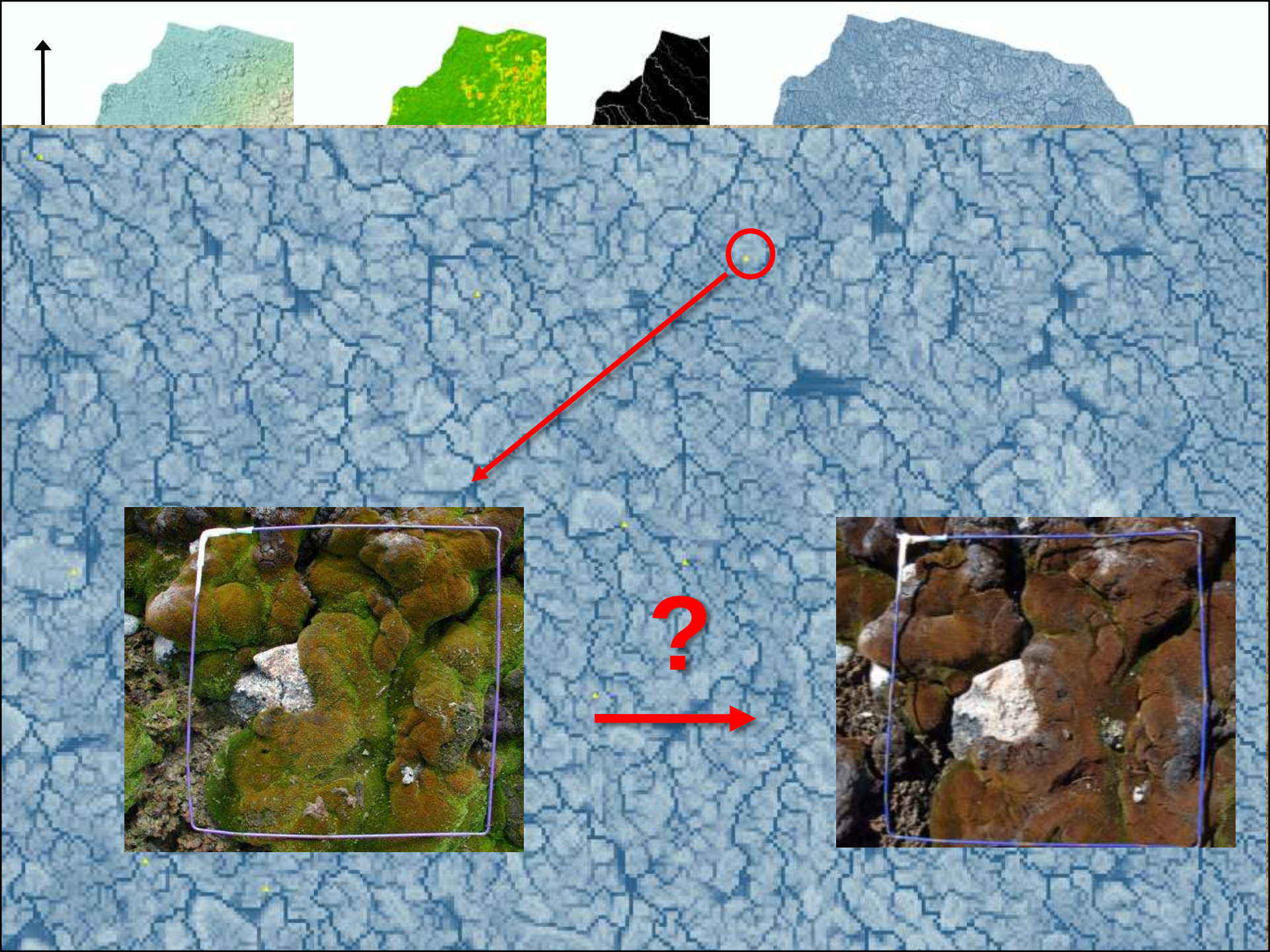


Traditional interpolated TIN

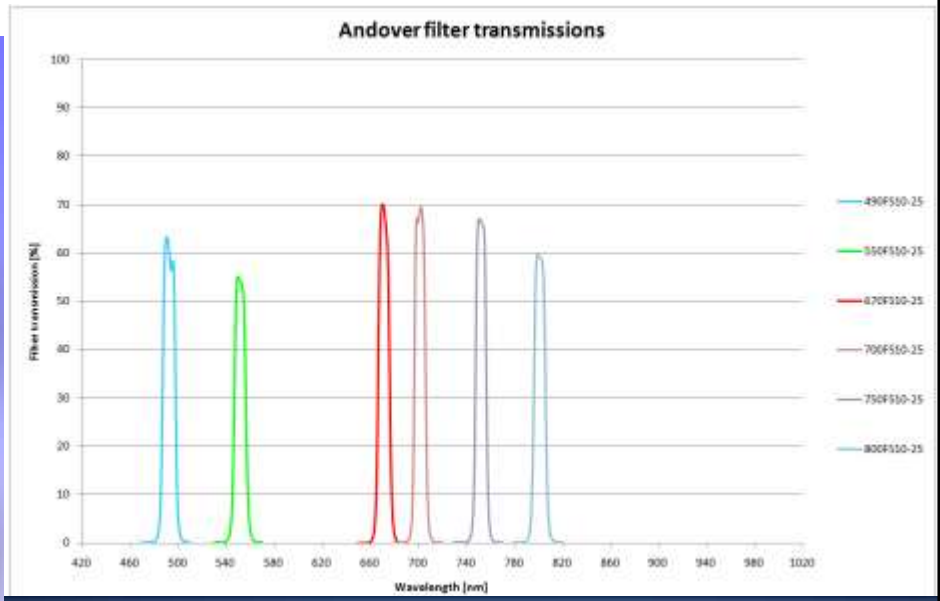
OR

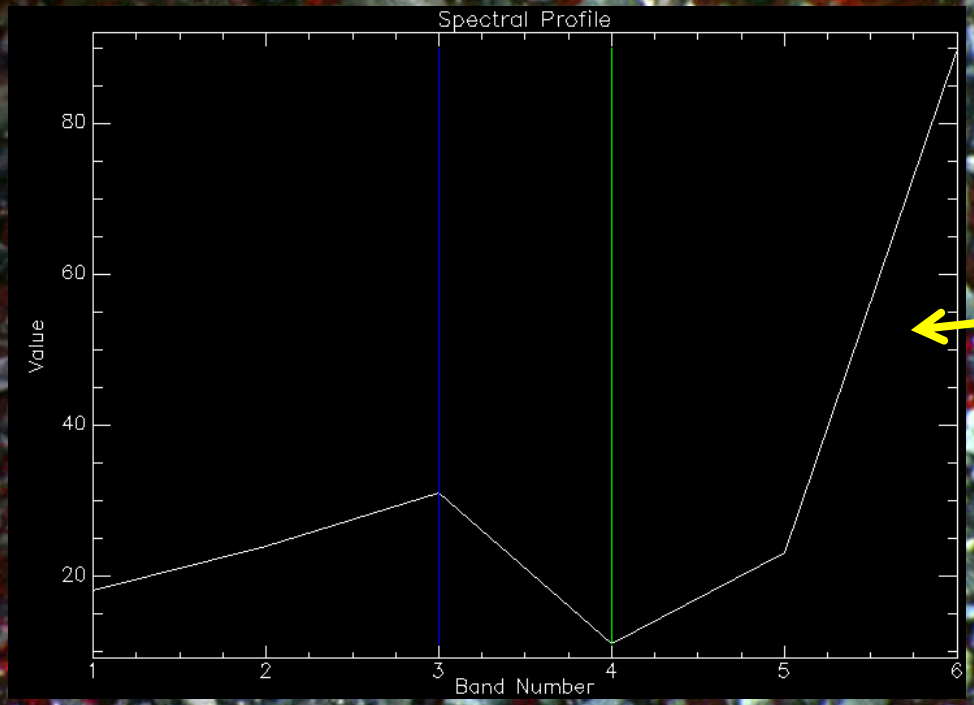


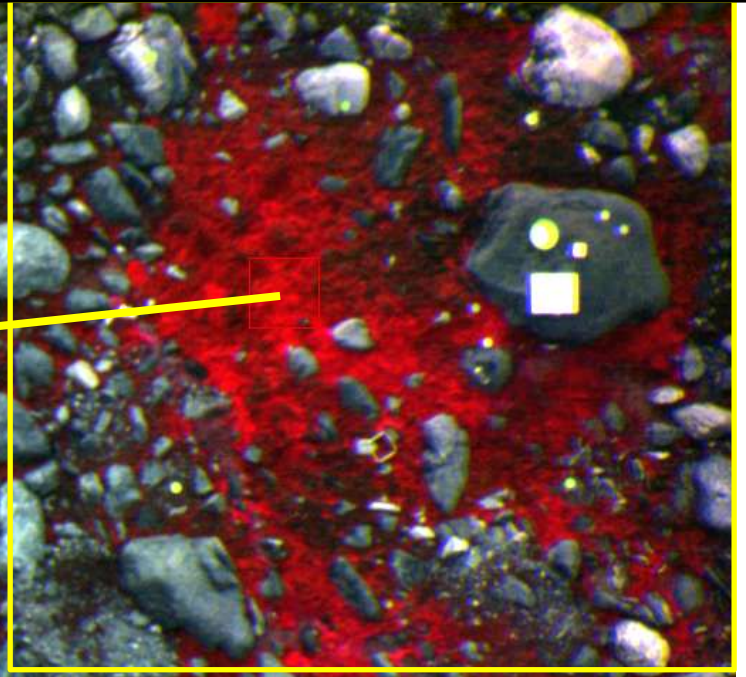
Poisson 3D surface construction
(Kazhdan *et al.* 2006)

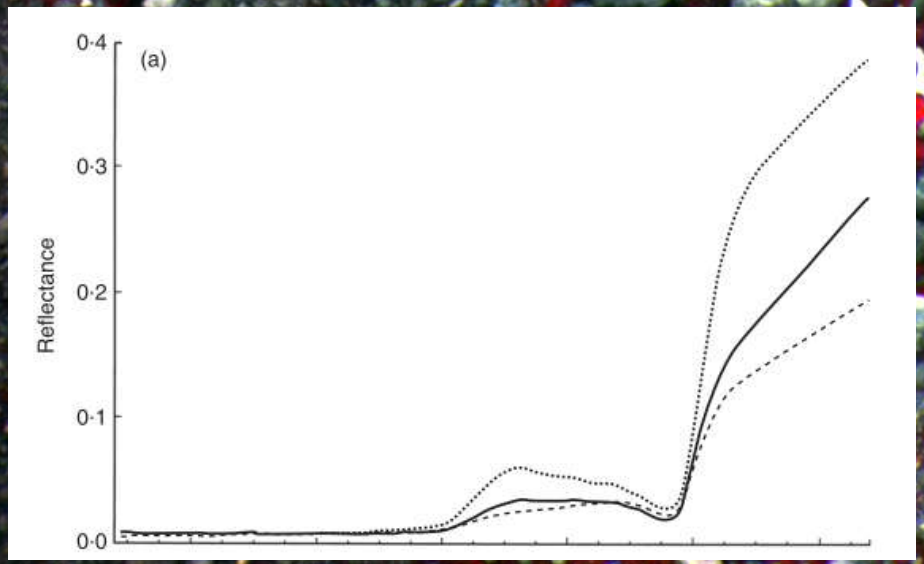


Multispectral *imaging* sensor 6-bands

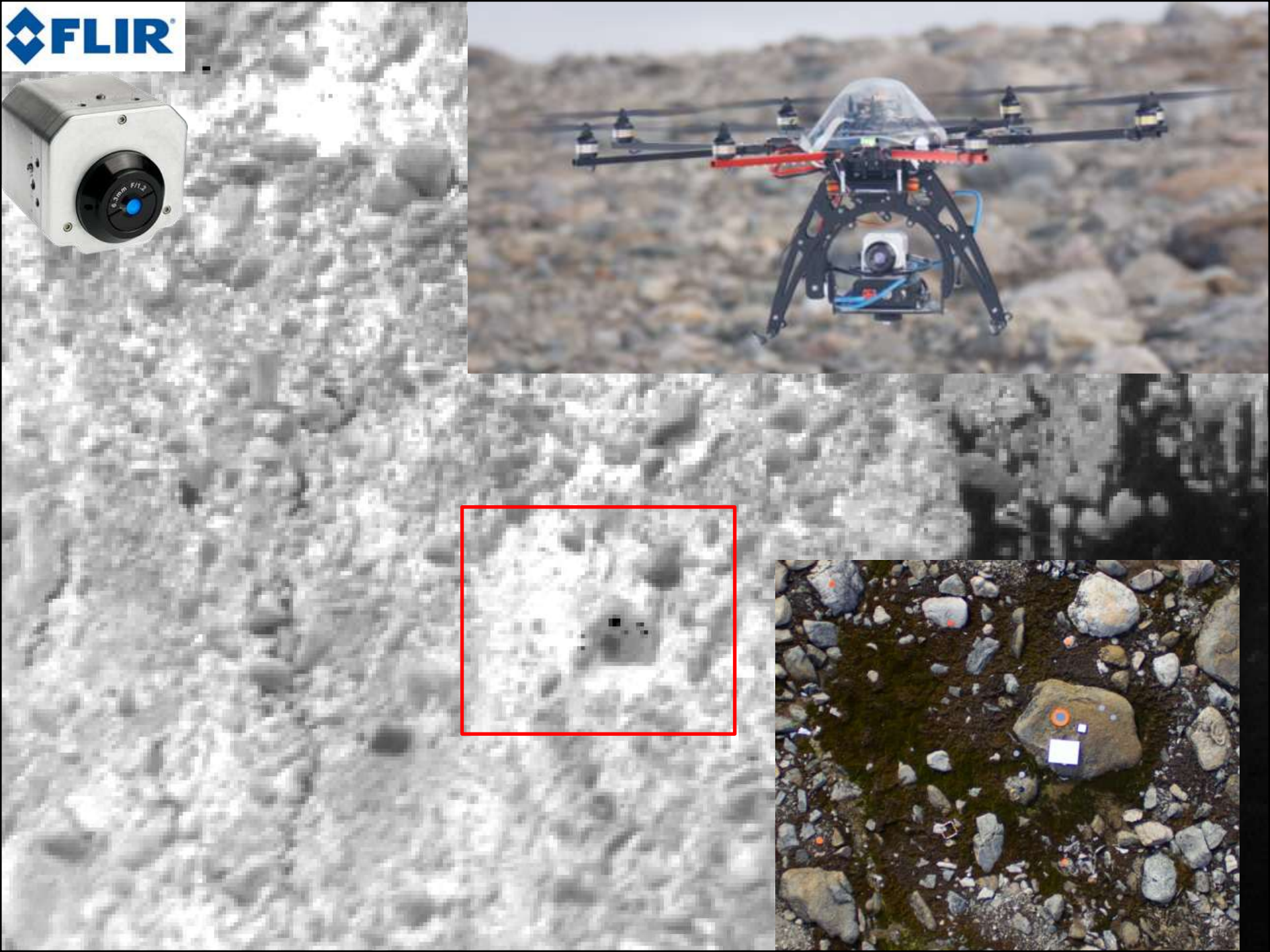



Spectral Profile
80
60
40
20
Value
1
2
3
4
5
6
Band Number

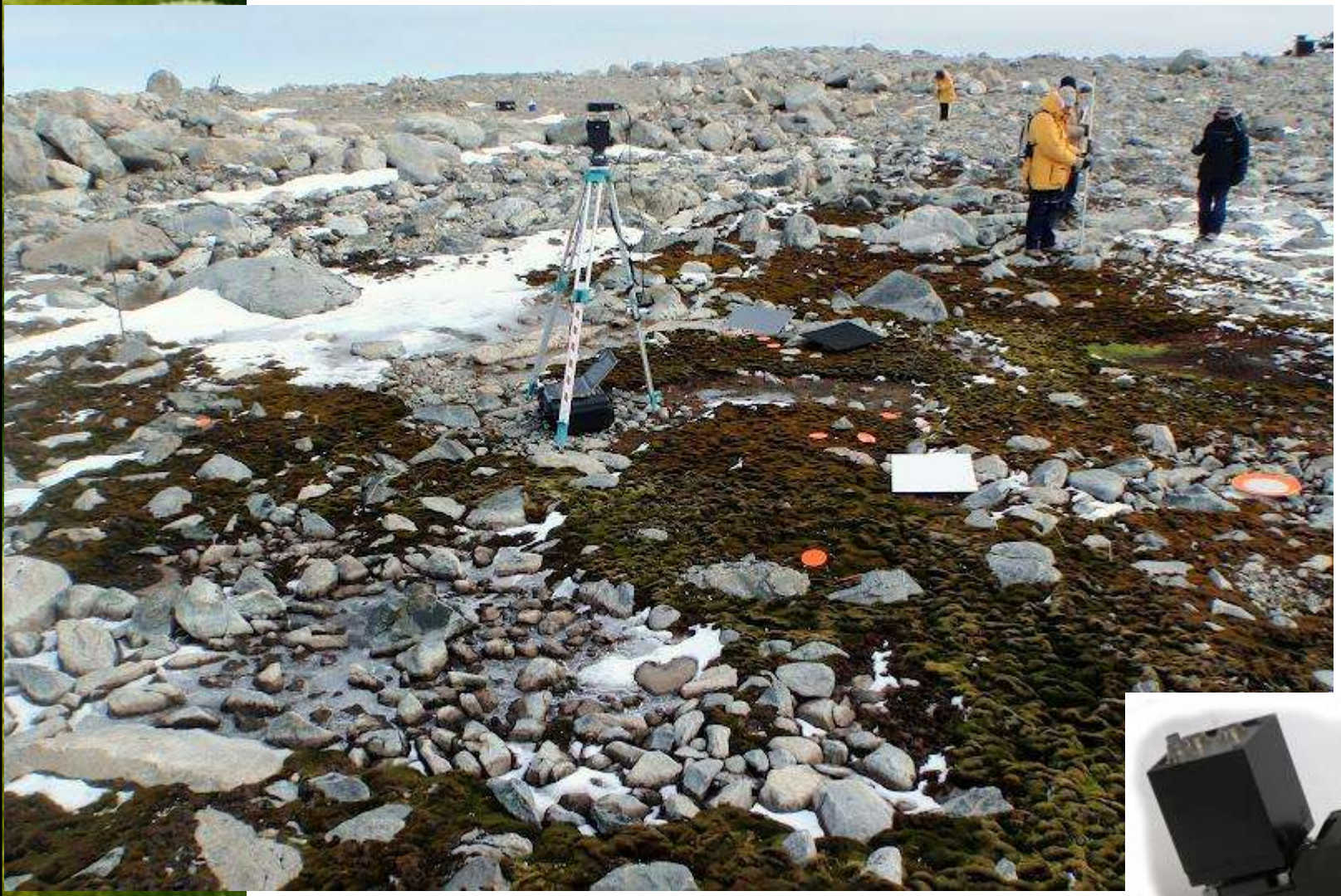



0·4
(a)
0·3
0·2
0·1
0·0
Reflectance


16
-1
Trefl=-9 Tatm=-9 Dst=2.0 FOV 23
2011-02-24 17:12:38 -10 - +55 e=0.98
°C


FLIR

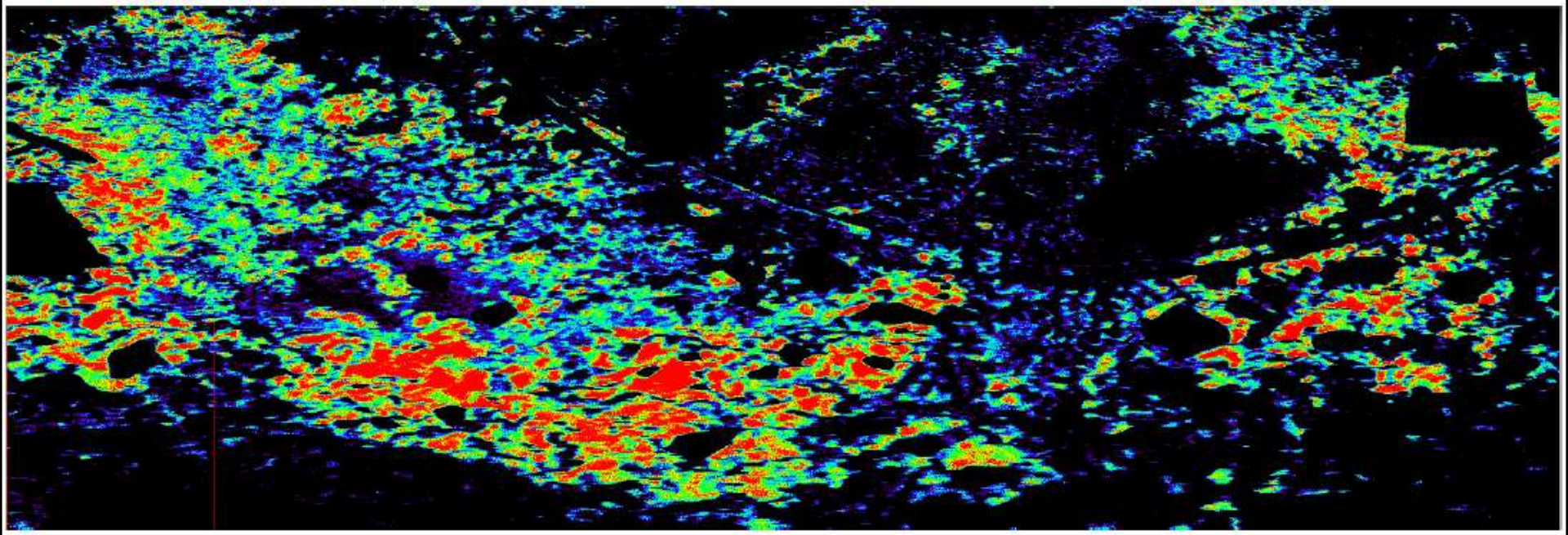
Hyperspectral field scans



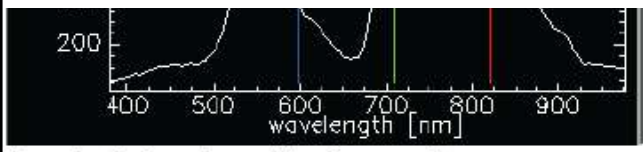
Source: Zbynek Malenovsky

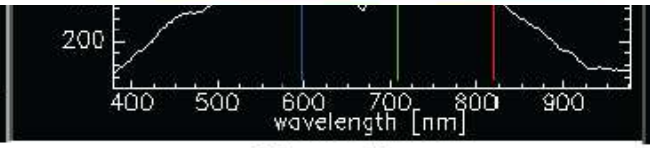
Hyperspectral field scanning

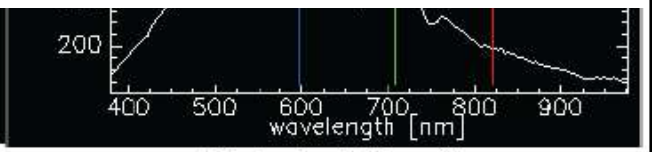
HYPERSPECTRAL SCAN OF MOSS-BED AT ASPA 135 (Casey, Antarctica, 29-01-2012, diffuse irradiance ~ full overcast)
Sensor: HyperSpecII (Headwall), spectral binning 2x, integration time 40 ms, gain 3.



Estimated Actual Stress Level:

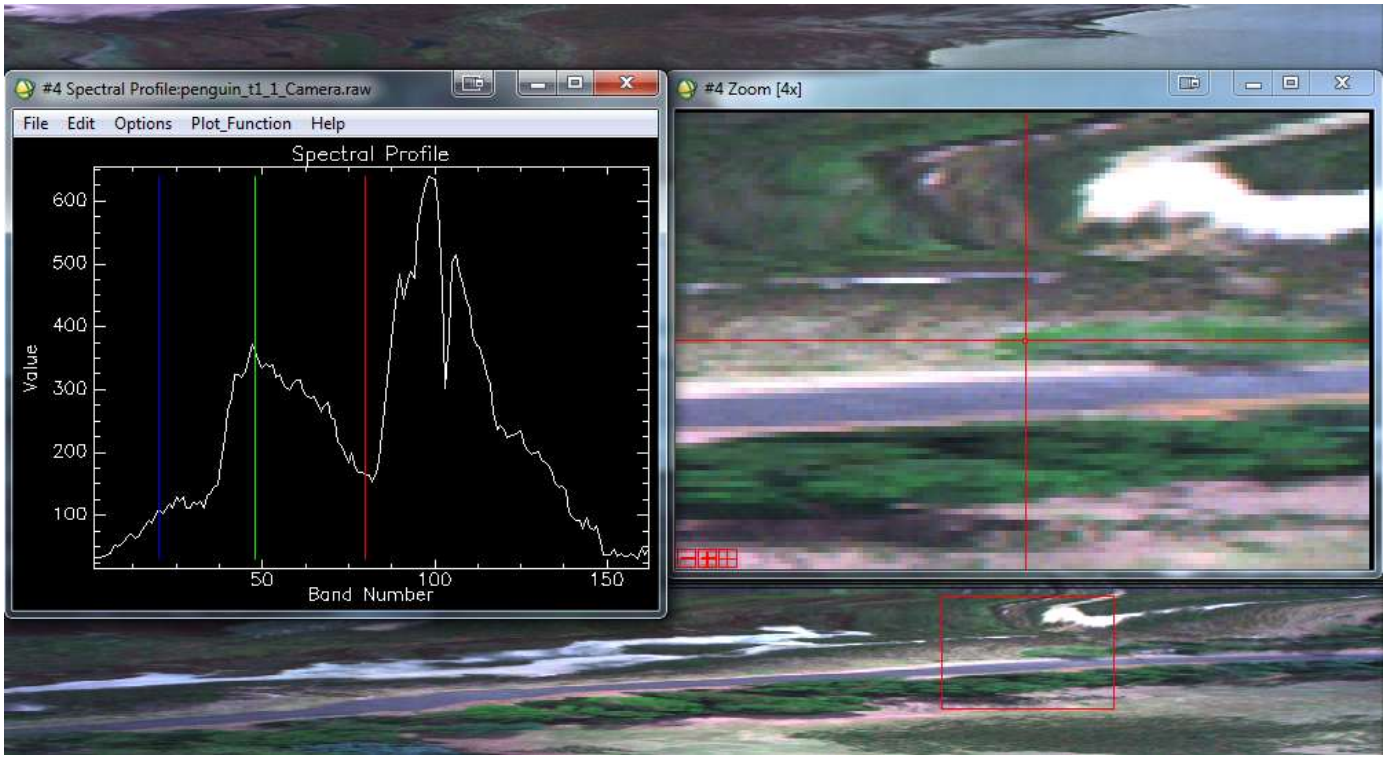






Spectral signature: **Unstressed moss** | **Stressed moss** | **Disturbed (dead) moss**
Normalized Difference Veg. Index: **NDVI = 0.45** | **NDVI= 0.10** | **NDVI ~ 0.00**
(DN ~ Digital Numbers of the reflected light intensity in 12-bit digitalization)

Hyperspectral UAV



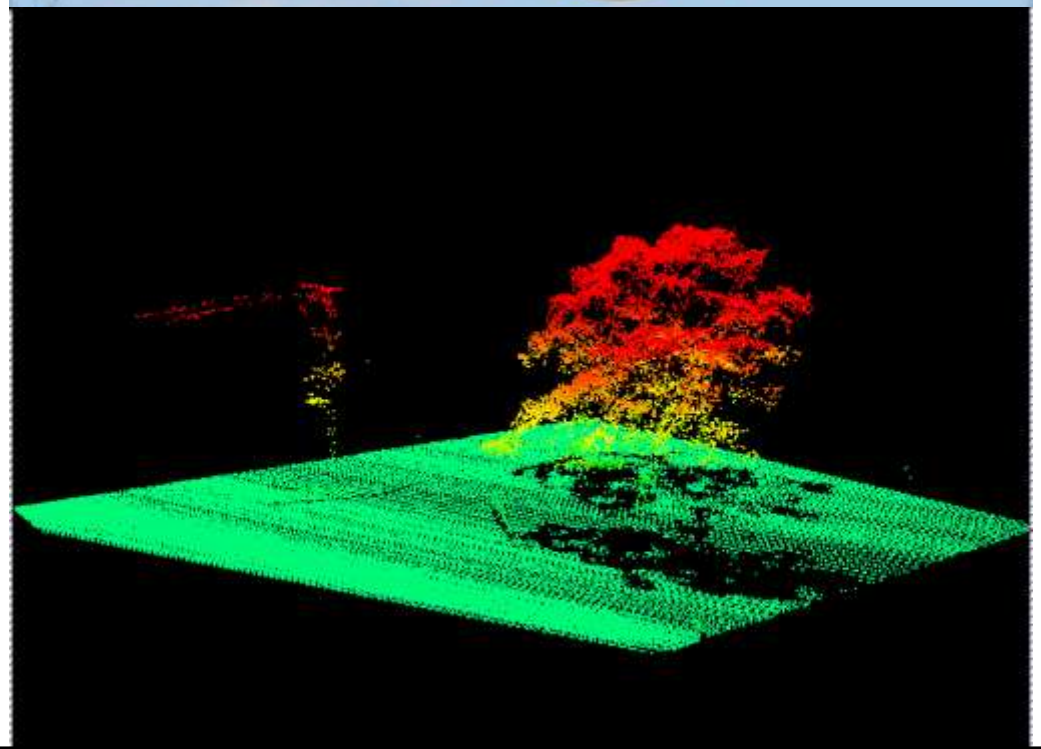
TerraLuma

UTAS

SkyJib – 5+ kg payload

TerraLuma

LiDAR Okto



UTAS

Conclusions

- UAV is an effective tool to capture the scale niche required for moss bed mapping (and monitoring)
- SfM and multi-view stereo techniques are suitable for dense reconstruction of 3D terrain geometry
- DEM generated from point clouds and DEM derivatives provide important environmental indicators for moss bed health
- Future work will focus on integration of multiple sensors and hyperspectral capabilities

Acknowledgements

- Australian Antarctic Division
- Casey expeditioners
- Australian Research Council
- Dr Christopher Watson (UTAS)
- Prof Richard Coleman (ARC)
- Geoffrey Fenn, Greenability
- Winifred Violet Scott Trust
- School of Geography & Environmental Studies

- Contact details:

Dr Arko Lucieer

University of Tasmania

School of Geography and Environmental Studies

03 6226 2140

Arko.Lucieer@utas.edu.au

http://www.lucieer.net

http://www.terraluma.net